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G1S 15

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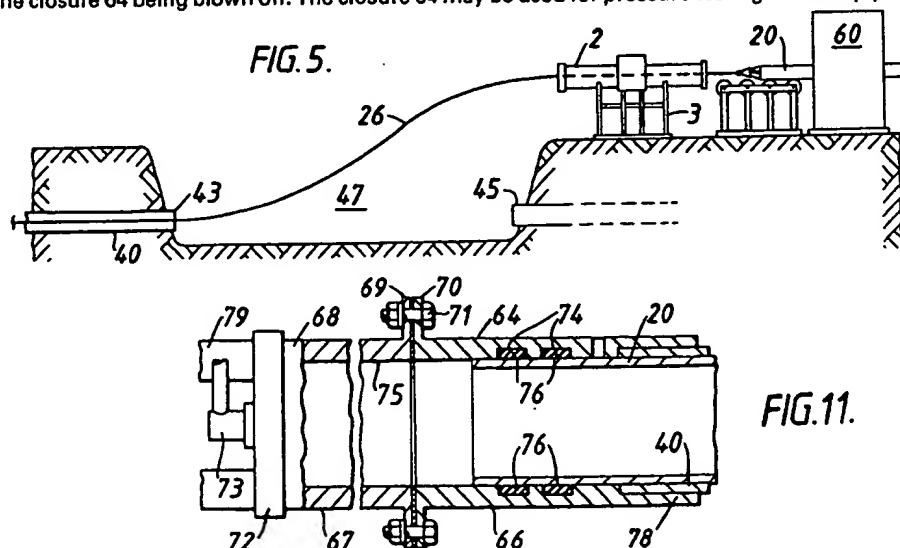
(58) Field of search

F2P  
G1S  
Selected US specifications from IPC sub-class F16L

## (54) Pipe lining and closure therefor

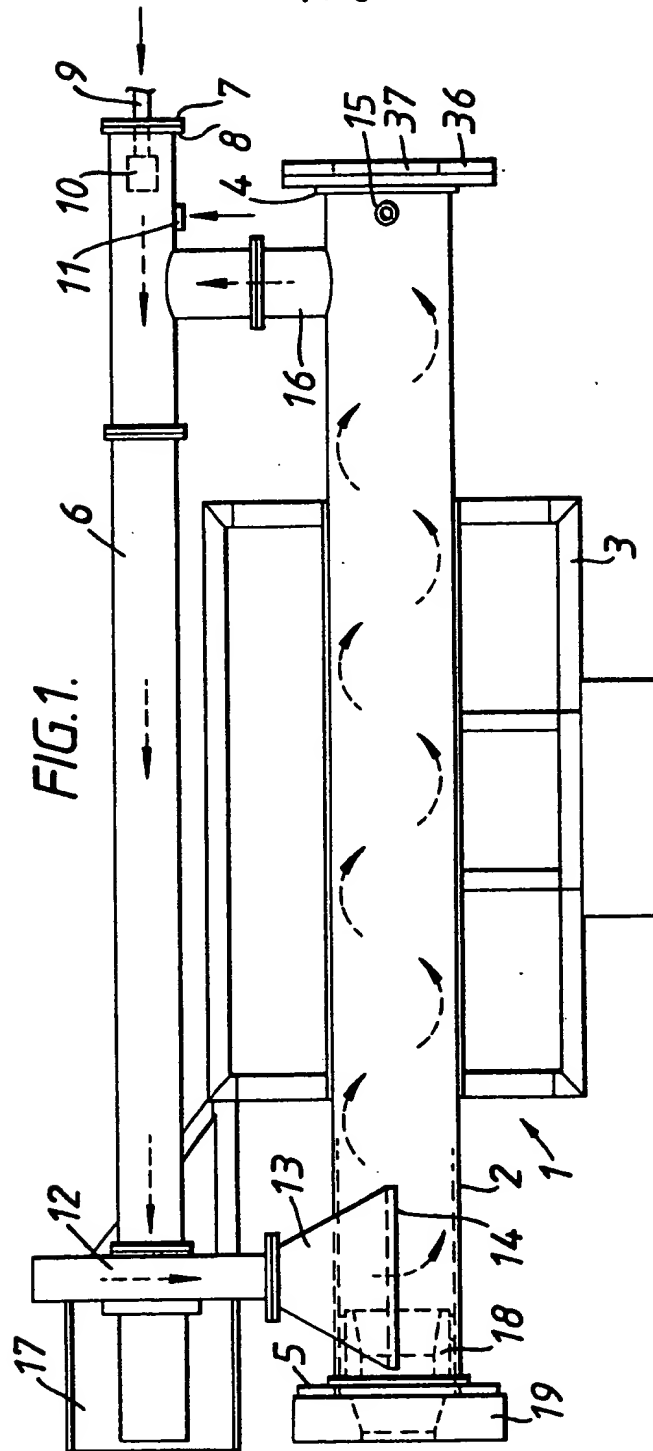
(57) A method for lining a pipe or main comprising heating a length of synthetic-resin liner pipe 20 of external diameter substantially equal to or greater than the internal diameter of the pipe or main 40 to be lined, mechanically deforming the heated liner pipe 20 to reduce its external diameter to less than the internal diameter of the pipe or main 40 to be lined, causing the liner pipe 20 to enter the pipe or main 40 to be lined and pressurising the internal wall of the liner pipe 20 to cause it to expand into engagement with the internal wall of the pipe or main 40 to be lined.

A closure 64 for sealing each end of the liner pipe 20 during pressurization thereof comprises a recessed end 78 to accommodate the main 40, O-ring seals 76, a valve inlet 73 for connection to a compressor and struts 79 to prevent the closure 64 being blown off. The closure 64 may be used for pressure testing the liner pipe 20.



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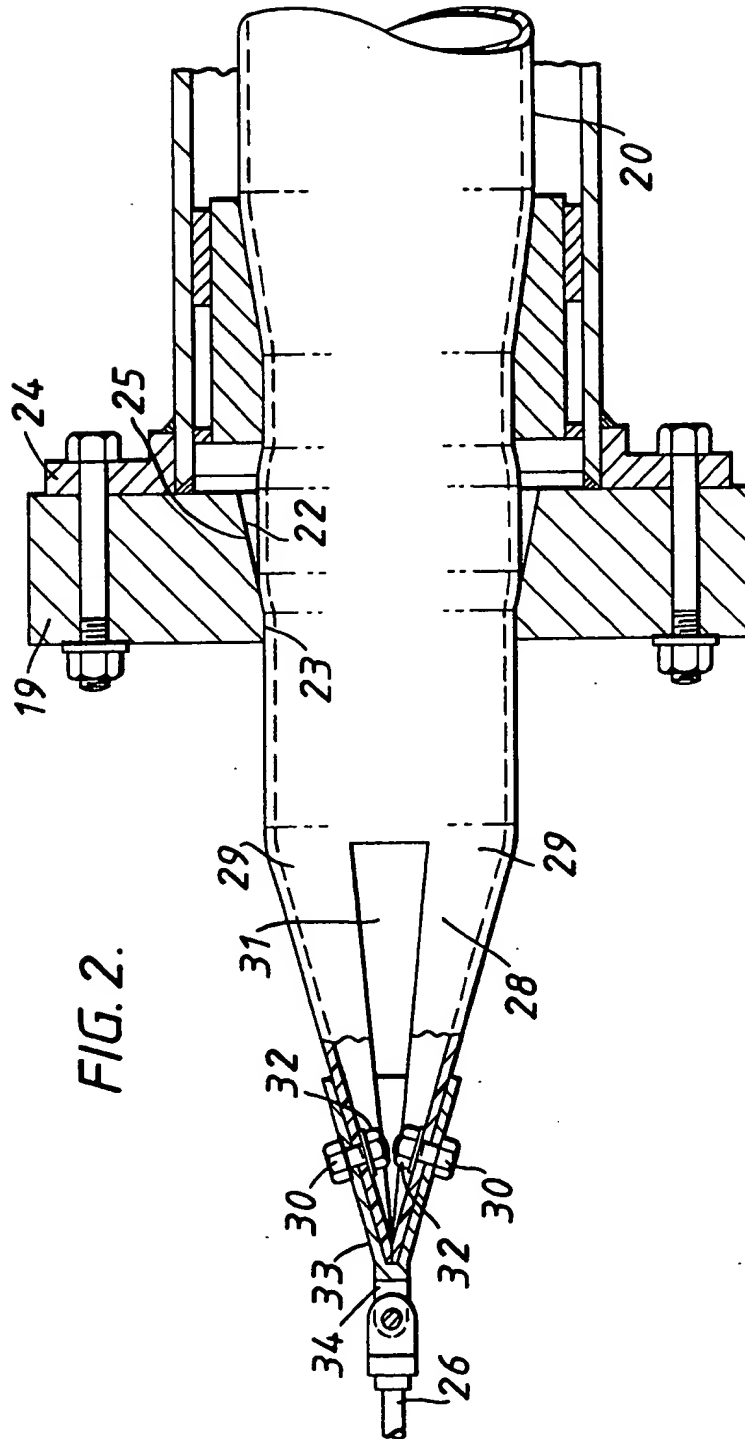
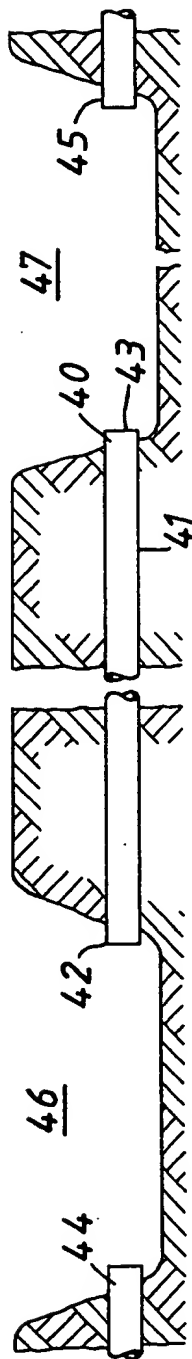
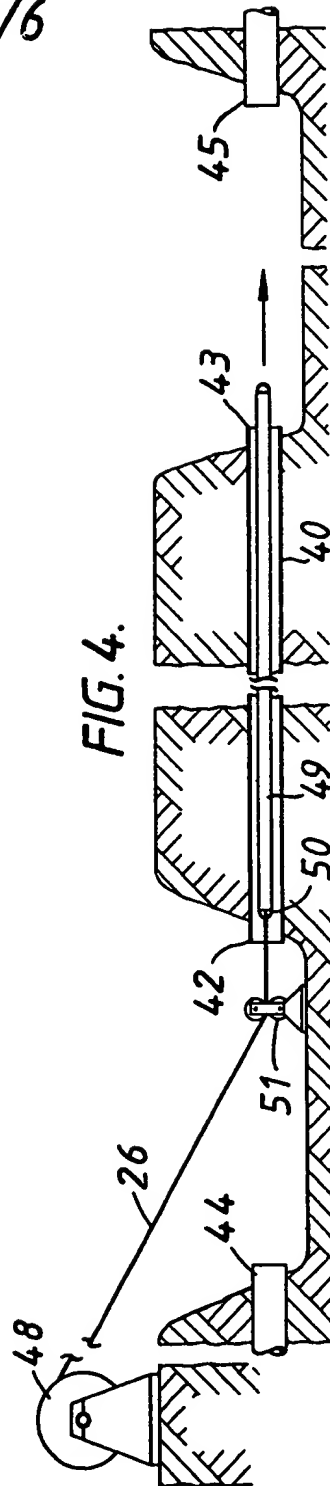


FIG. 3.



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FIG. 4.



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FIG. 5.

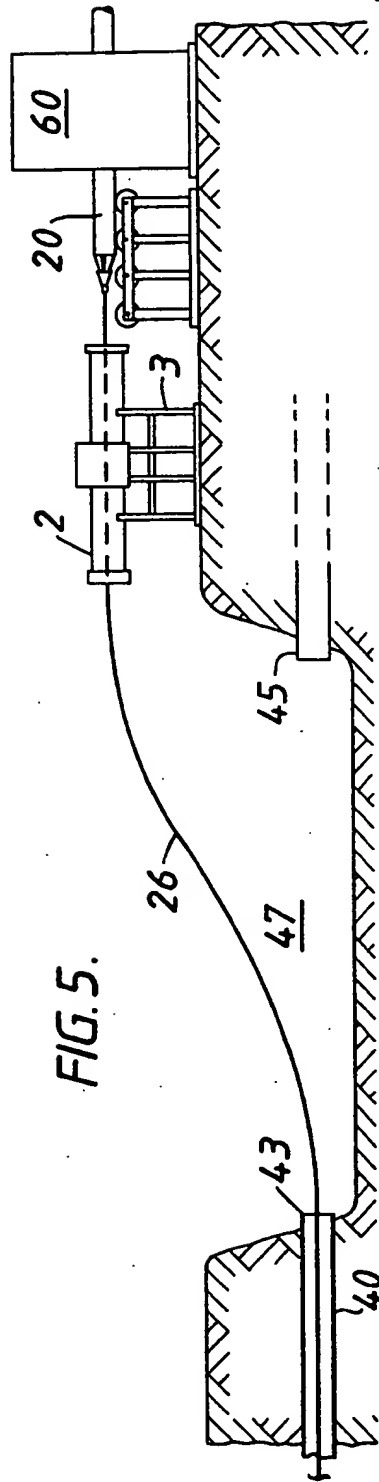
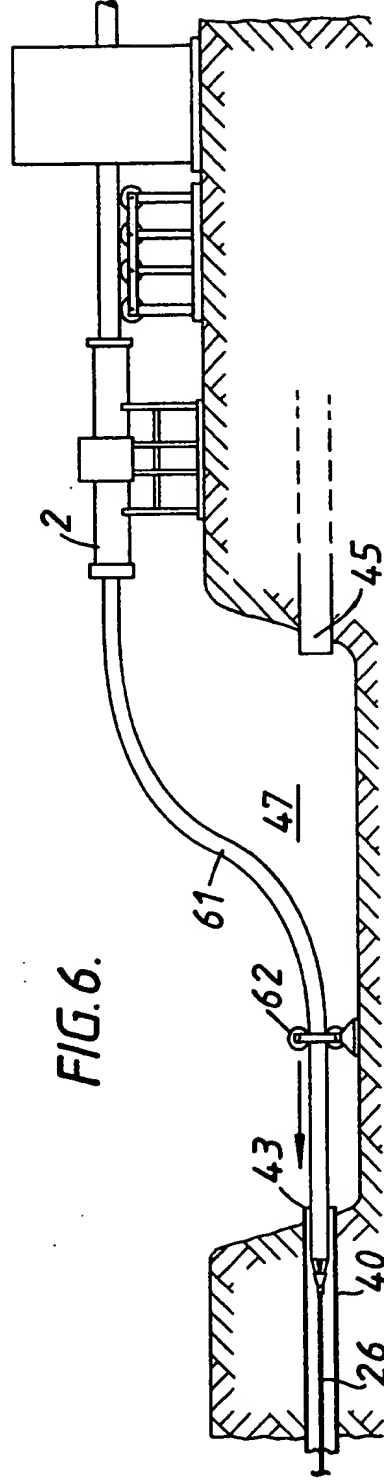


FIG. 6.



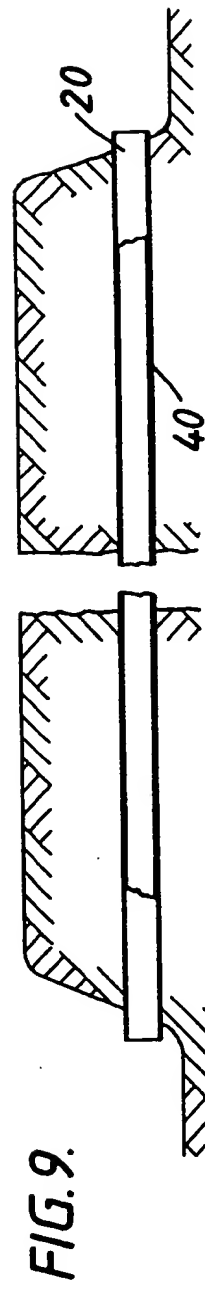
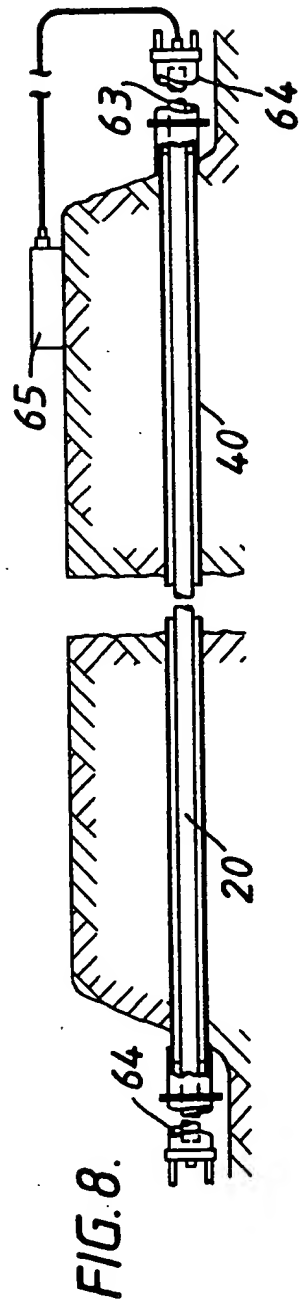
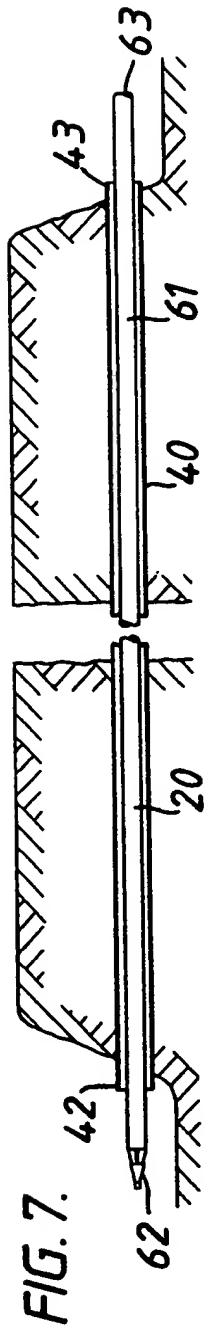


FIG. 10.

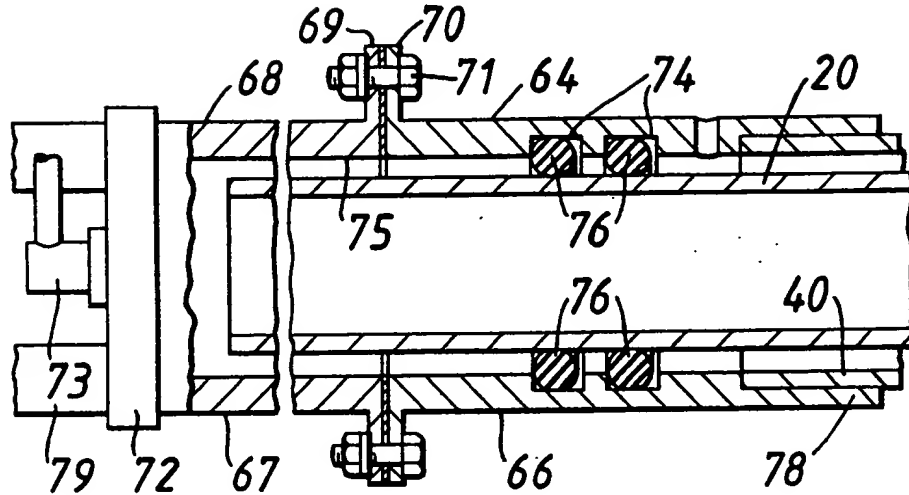
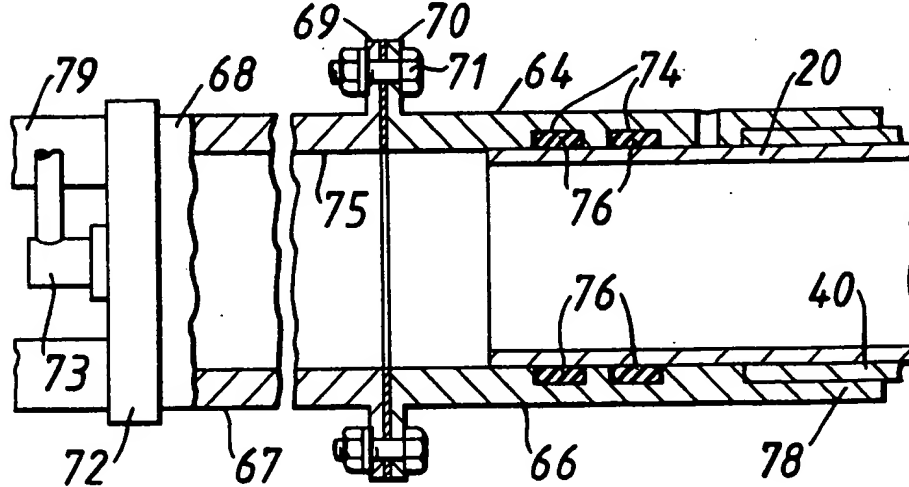


FIG. 11.



## SPECIFICATION

## Method for lining a pipe or main

The present invention relates to a method for  
5 lining a pipe or main and is particularly directed to  
the lining of underground gas or water mains or  
sewer pipes.

According to one aspect of the present invention  
we provide a method for lining a pipe or main  
10 comprising heating a length of synthetic-resin liner  
pipe of external diameter substantially equal to or  
greater than the internal diameter of the pipe or  
main to be lined, mechanically deforming the  
heated liner pipe to reduce its external diameter to  
15 less than the internal diameter of the pipe or main to  
be lined, causing the liner pipe to enter the pipe or  
main to be lined and pressurising the internal wall of  
the liner pipe to cause it to expand into engagement  
with the internal wall of the pipe or main to be lined.

20 According to another aspect of the present  
invention a closure is provided for closing off the  
end of a synthetic resin liner pipe during internal  
pressurisation of the pipe with a pressurising fluid,  
the closure comprising a cap having a sleeve  
25 portion adapted to receive the end of the pipe with  
clearance and flexible sealing means located within  
the sleeve and adapted to engage the outer surface  
of the pipe and form a seal between the outer  
surface of the pipe and the inner surface of the  
30 sleeve portion.

An embodiment of the present invention will now  
be particularly described with reference to the  
drawings in which:—

Figure 1 is a plan view of a rig suitable to preheat  
35 and reduce the external diameter of a length of liner  
pipe,

Figure 2 is a more detailed cross-section of the  
front end of the rig in use,

Figures 3 to 9 show in schematic form a typical  
40 sequence of operations in the lining of a section of  
an existing main, and

Figures 10 and 11 are longitudinal sections  
through one form of device for closing the ends of  
the liner pipe so that it can be expanded by  
45 pressurisation, Figure 10 showing the situation  
before expansion and Figure 11 the situation after  
expansion.

Referring to Figure 1 the rig 1 comprises a heater  
tube 2 which in use is supported above ground on a  
50 support frame 3 (see also Figures 5 and 6). The tube  
2 has a rear end 4 to receive a liner pipe for  
preheating on passage through the tube 2 and a  
front end 5 adapted to reduce the external diameter  
of the preheated liner pipe.

55 Extending parallel to the heater tube 2 is a smaller  
diameter tube 6 serving to provide hot gas for  
preheating a liner pipe within the heater tube 2.

The tube 6 is closed at a rear end 7 by an  
apertured plate 8 through the aperture of which  
60 extends a gas supply pipe 9 for supplying gas to a  
gas fired burner 10 located within the tube 6. The  
tube 6 is provided with an air-intake 11 at a point  
adjacent to the plate 8 to supply air for combustion  
of the gas within the burner 10.

65 Hot gas supplied by the burner 10 travels

forwardly in the direction of the arrows to an  
elongated chamber 12 forming the front end of the  
tube 8. The chamber 12 terminates in a distributor  
13 which has a rectangular outlet 14 communicating  
70 with a similar shaped rectangular slot in the wall of  
the heater tube 2. In this way the hot gas is caused to  
enter the heater tube 2 from the chamber 12 radially  
at a point adjacent to its front end 5 taking the  
direction of the arrows. Once inside the tube 2, the  
75 gas travels rearwardly in the direction of the arrows.

Some of the hot gas then leaves the tube 2 by way  
of an exhaust pipe 15 located adjacent to the rear  
end 4 of the tube 2. The remaining majority of the  
hot gas re-enters the tube 6 by way of a radial tube  
80 16 connecting the tubes 2 and 6 at a point adjacent  
to their rear ends.

The chamber 12 is provided with a circulating fan  
17 to cause the circulation of the gas within the  
assembly to be accelerated.

85 Referring to Figures 1 and 2 the front end of the  
tube 2 is formed by two swaging dies 18 and 19  
serving in use to reduce the external diameter of the  
liner pipe 20 being drawn therethrough.

A first die 18 is located within the tube 2 and is  
90 held within a die holder 21 secured to the internal  
wall of the tube 2. The first die 18 has a forwardly  
tapering entry section 22 leading to a circular exit  
section 23. The tapering entry section 22 serves to  
provide the initial and major proportion of the  
95 reduction in the external diameter of the preheated  
liner pipe 20 as shown in Figure 2.

The second die 19 is located beyond the end of the  
tube 2 and is bolted to a circular flange 24 welded to  
the outer surface of the tube 2. The second die has a  
100 forwardly tapering aperture 25 serving to provide a  
final and minor proportion of the reduction in the  
external diameter of the preheated liner pipe 20.

In use, the preheated liner pipe 20 is drawn  
sequentially through the dies 18 and 19 by means of  
the cable 26 of the winch (shown in Figure 4). To  
105 achieve this the leading end of the liner pipe 20 is  
formed in the shape of a cone 28 by cutting the end  
of the liner pipe 20 into suitably triangular portions  
29, folding the portions 29 to form the cone 28 and  
then welding adjacent portions 29 together. These  
110 portions 29 are formed with holes to receive the  
ends of bolts 30 and gaps 31 are left between the  
portions 29 so that when the cone 28 has been  
formed the inside of the cone 28 can be accessed  
manually to place nuts 32 on the ends of the bolts  
115 30. Next a steel cone 33 matching the tip of the pipe  
cone 28 is placed over the tip as shown in Figure 2,  
the steel cone 33 having holes to correspond with  
those in the pipe cone 28, and the cones 28, and 33  
are bolted together by the nuts and bolts 30 and 32.

120 The steel cone 33 has an eye 34 which is in use as  
shown in Figure 2 connected to the cable 26 of the  
winch.

The internal diameter of the wall of tube 2 is  
125 greater than the external diameter of the liner pipe  
20 so that an annular space 35 is formed between  
the outer wall of the liner pipe 20 and the inner wall  
of the tube 2. In use, this space 35 when the liner  
pipe 21 is within the tube 2 is enclosed at one end by  
130 the internal die 18 and at the other end by an



apertured plate 36 attached to the rear end 4 of the tube 2, the wall of the aperture 37 in the plate 36 forming a close fit with the external wall of the liner pipe 20. Thus, the hot gas entering the tube 2 from the distributor 13 is caused to flow within the enclosed annular space 35 to heat the external wall of the liner pipe 20.

Referring to Figures 3 to 9, in the first stage of the lining process (Figure 3) the section 40 of the main 41 to be lined has ends 42,43 isolated from adjacent portions 44,45 of the main 41. This is done by digging excavations 46,47 at two distant points in the main 41 and then removing pieces from the main 41 to expose the ends 42,43 of the section 40.

In the next stage of the process (Figure 4) a motorised winch 48 is mounted at ground level adjacent to the end 42 of the main section 40. A stiff rod 49 is then pushed along the main section 40 from the end 42 to the end 43. That end 50 of the rod 49 nearest the winch 48 is connected to the winch cable 26 after the cable 26 has been fed through guide rolls 51 mounted on the floor of the excavation 46. The rod 49 is then pushed completely through the main section 40 so that the cable 26 eventually emerges from the end 43 of the section 40. The cable 26 is then detached from the rod 49 and is fed through the reducing rig 1 as shown in Figure 5. The cable 26 is then attached to the leading end of the pipe liner 20 in the manner previously described with reference to Figure 2. Sections of the pipe liner 20 are fed successively to a butt-welding machine 60 located upstream of the reducing rig 1. The machine 60 enables adjoining ends of the pipe liner sections 20 to be butt welded together to form a continuous length. The machine 60 may have facilities for removing both internal and external weld beads from the pipe liner which ideally is of polyethylene.

The motor of the winch 48 is then actuated to draw the cable 26 towards the end 43 of the main section 40 as shown in Figure 6. This causes the liner pipe 20 to enter the heater 2 through which hot gas is circulating. The liner pipe 20 is then preheated by the gas in the manner previously described to a temperature of about 100°C and the preheated pipe 20 is then drawn through the dies to effect a reduction in the external diameter of the pipe 20 to an extent permitting the reduced diameter pipe 61 to enter the end 43 of the main section 40 by way of guide rolls 62 mounted on the floor of the excavation 47.

The reduced diameter pipe 61 is then drawn as a continuous length along the main section 40 to and out of the far end 42 as shown in Figure 7. The reduction in diameter of the liner pipe 20 may be of the order of 3% or more.

Once the liner pipe 20 has reached and extended beyond the far end 42 of the main section 40, the winch cable 26 is disconnected from the eye 34 on the steel cone 33. The steel cone 33 is then removed from the pipe cone 38 thus leaving the liner pipe 20 with ends 62 and 63 lying exposed beyond the ends 42,43 of the main section 40.

Both ends of the pipe 20 are closed by closures 64 and air is injected into one end of the pipe 20 by

means of a compressor 65 mounted at ground level adjacent to the end 63 of the main section 40 as shown in Figure 8. The air is injected at super atmospheric pressure e.g. 2 to 6 bar for an extended period say 24 hours. This causes the liner pipe 20 to expand into contact with the internal wall of the main section 40 as shown in Figure 9.

A suitable closure 64 for the liner pipe 20 is shown in Figures 10 and 11. The closure 64 comprises a tubular sleeve 66 for receiving one end of the liner pipe 20 and a cap 67 for attachment to the sleeve 66.

The cap 67 has a cylindrical portion 68 having an outwardly flanged open end 69 for connection to a similar outwardly flanged end 70 on the sleeve 66 by means of several nut and bolt assemblies 71 (only two shown). The cap 67 has one end closed by a plate 72 which has a valve 73 which is adapted when open to connect the interior of the closure 64 to a compressor or like device for supplying air under pressure to the closure 64. Alternatively the valve 73 can be closed when the closure 64 is serving as a seal for preventing the escape of air from one end of the liner pipe 20 when air is being injected at the other end.

Located in two circumferential grooves 74 on the inner surface 75 of the sleeve 66 are two O-ring seals 76 which are arranged to engage the outer surface 77 of the liner pipe 20 when an end of the pipe is located within the sleeve 66. These seals 76 form a seal between the outer surface 77 of the liner pipe 20 and the inner surface 75 of the sleeve 66 and permit movement of the liner pipe 20 within the sleeve 65 since the liner pipe 20 expands radially and contracts longitudinally as pressure is applied to the interior of the liner pipe 20.

In use, both the exposed ends of the liner pipe 20 are closed with a closure device 64. The sleeve 66 may have a recessed end portion 78 to fit over the spigot end of the main section 40 as shown in Figures 10 and 11. Each closure 64 is supported against the internal walls of the excavation by means of struts 79 extending outwardly from the cap 67 to prevent its being blown off during pressurisation of the closure 64. One of the closure devices 64 is connected to the compressor 65 by means of the valve 73 which is opened. The valve 73 of the other closure device is closed. Air is then supplied by the compressor to pressurise the liner pipe 20. After use, the closure devices 64 are removed and the ends of the liner pipe 20 are connected up to the adjacent portions 44 and 45 of the main 41 by conventional means.

The pressurisation of the liner pipe may form part of a standard pressure test to test the soundness of the liner pipe.

#### CLAIMS

1. A method for lining a pipe or main comprising heating a length of synthetic-resin liner pipe of external diameter substantially equal to or greater than the internal diameter of the pipe or main to be lined, mechanically deforming the heated liner pipe to reduce its external diameter to less than the internal diameter of the pipe or main to be lined, causing the liner pipe to enter the pipe or main to be

lined and pressurising the internal wall of the liner pipe to cause it to expand into engagement with the internal wall of the pipe or main to be lined.

2. A method as claimed in claim 1 in which the  
5 liner pipe is of polyethylene.

3. A method as claimed in claim 1 or claim 2 in which the liner pipe is drawn into the pipe or main to be lined.

4. A method as claimed in claim 3 in which the  
10 liner pipe is drawn into the pipe or main to be lined by means of a cable attached to the leading end of the liner pipe.

5. A method as claimed in claim 4 in which the cable is wound onto the drum of a motorised winch  
15 to draw the liner pipe into the pipe or main to be lined.

6. A method as claimed in any of claims 3 to 5 in which the liner pipe is mechanically deformed by being drawn through one or more swaging dies  
20 dimensioned to reduce the external diameter of the liner pipe to less than the internal diameter of the pipe or main to be lined.

7. A method substantially as hereinbefore described with reference to the accompanying  
25 drawings.

8. A closure for closing off the end of a synthetic resin liner pipe during internal pressurisation of the pipe with a pressurising fluid, the closure comprising a cap having a sleeve portion adapted to  
30 receive the end of the pipe with clearance and flexible sealing means located within the sleeve and adapted to engage the outer surface of the pipe and form a seal between the outer surface of the pipe and the inner surface of the sleeve portion.

9. A closure as claimed in claim 8 in which the sealing means comprises at least one O-ring.

10. A closure as claimed in claim 8 or claim 9 in which the closure is provided with an inlet for supplying pressurised fluid to the interior of the  
35 closure.

11. A closure as claimed in claim 10 in which the inlet comprises a closable valve.

12. A closure substantially as hereinbefore described with reference to Figures 10 and 11.